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ABSTRACT

Presented are first-revision materials of the K-12 unified science program implemented in the public schools of Anne Arundel County, Maryland. Detailed descriptions are given of the roles of students and teachers, purposes of bibliography, major concepts in unified science, processes of inquiry, scheme and model for scientific literacy, and program rationale, design, and strategies. The first six proficiency level statements are provided together with 50 proficiency level objectives. Each objective is further analyzed into a number of educational objective statements. The content is related to such aspects as plants, animals, food chain, seed growth, solar system, matter, space, forces, heat, light, photosynthesis, pollution, electric circuits, chemical reactions, magnets, energy, friction, and levers and inclined planes. Included are a list of elementary projects, kits, and materials and bibliographies of selected elementary, secondary, and professional readings. (CC)

Unified Science Approach
K-12

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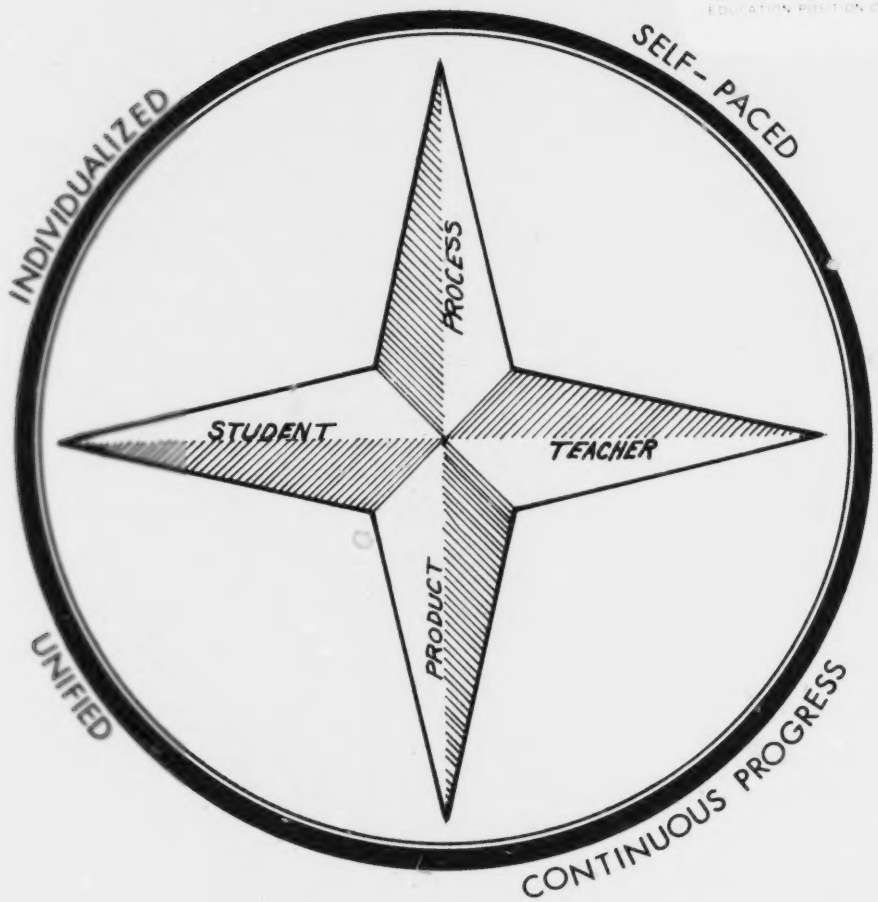

Anne Arundel County
Annapolis, Maryland

PROFICIENCY LEVELS I-VI

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A

K-12 UNIFIED

SCIENCE APPROACH

PROFICIENCY LEVELS I - VI

Dr. Edward J. Anderson, Superintendent
Public Schools of Anne Arundel County
Annapolis, Maryland 21404

September, 1972
(Revised)

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DEFINITIONS

Implementation Team: Those individuals designated to give support to and work with personnel in schools where program implementation is occurring by interpreting the program and assisting in the achievement of program objectives.

Individualization: The method by which each student is engaged in the achievement of objectives through involvement in experiences (ranging from tutorial to large group situations) that are uniquely appropriate to his learning style and which require active participation (mentally and/or physically) as he progresses as far and as rapidly as his interests or abilities permit.

Instructional Team: Those individuals involved in implementing the program at the school level, including teachers, administrators, supervisors, and implementation team members when team members are engaged in activities with school personnel.

Inquiry: A method of discovery of knowledge by which the student observes, hypothesizes, analyzes, experiments, interprets, and predicts.

Learning Package: A unit of related content and activities organized for mastery of a stated problem or question. The learning package includes: specific cognitive and affective objectives with appropriate criterion measures: instructional strategies; necessary personnel; and suggested supplies, materials, equipment and facilities.

Major Unifying Concepts: Major science concepts which are interrelated and interdependent ideas crossing discipline boundaries and demonstrating the interrelationships among the sciences.

Process: Specific mental or operational skills that transform random cognitive or affective knowledge in such a way so as to integrate it into a meaningful structure.

Product: The concepts, facts, theories, and laws of natural phenomena.

Proficiency Level: A specified area of content and process to be mastered. Rather than use age or grade levels, the content and processes are determined by determing a child's math skills, reading level, communicative skills, and psychomotor skills that are characteristic of children at various age levels.

DEFINITIONS

Proficiency Level Objective:	A measurable statement of the student's performance by which his acquisition of process and content relating to the proficiency level may be evaluated.
Scientific Literacy:	A scientifically literate person is one that knows and can apply the fundamental concepts and principles of science; understands the investigative nature of science; and has an appreciative attitude towards the role of science and the scientist in a modern society.
Self-Instructional Activities:	Activities designed so that the student would work more or less independently through a step-by-step sequence toward achievement of the objective, or in which the student is required to devise his own strategies for achievement of the objective.
Spiral:	A recurring topic ever expanding in complexity.
Unified Science:	An organizational and instructional approach which emphasizes a universal scheme of concepts permeating all science disciplines, and, in practice, builds upon interrelationships among science disciplines.
Educational Objective:	A concise statement of the goals or end product achieved from a learning experience. The objective involves procedures, conditions, and criteria of acceptable performance, and includes cognitive, affective, and psychomotor skills.

RATIONALE OF UNIFIED SCIENCE

The trend in science education today is not to think in terms of separate artificial barriers for each field of science, but to point out scientific principles common to all.

The unified science curriculum identifies major unifying concepts which permeate all of the science disciplines. These major concepts interrelate with principles of knowledge in each science area. The scientific principles in the disciplines then become the subconcepts which make up the broad body of knowledge or content which the student needs to acquire.

An education in science produces both the knowledge of basic scientific principles and command of the process by which they have been evolved. To accomplish this twofold purpose, The Anne Arundel County Unified Science Approach unites the processes of science with the products of scientific endeavor to produce the scientifically literate person. This goal of scientific literacy is reflected in the program's structural design feature of nine statements of scientific literacy.

Since students learn in different ways and at different rates, the program consists of a series of proficiency level objectives which each student accomplishes at his own pace.

PROGRAM DESIGN

The core of the program is organized around a series of twenty-one proficiency levels which are subdivided into proficiency level objectives. Each proficiency level objective unifies the process and the content of the life sciences, the physical sciences, and the earth sciences. There are educational objectives to measure learning experiences for each proficiency level objective. In determining what should be learned in each of these levels, student's cognitive, affective, and psychomotor development was considered. Although the program is designed to facilitate continuous progress in learning from K-12, the proficiency levels have been correlated to suggested grade levels to assist the teacher in the transitional and introductory phases. Upon completing the proficiency levels, specialized semester courses are available to students in terms of their interests, needs, and future plans.

PROGRAM STRATEGIES

1. A K-12 development of unified science provides for coherency and continuity of learning.
2. Science is presented as an inquiry process through which skills, information, and scientific literacy are developed.
3. A combination of the process of learning and the products of scientific knowledge provide a true learning situation.
4. The individualized nature of the program offers the student an opportunity to progress at his own pace.
5. The program is designed to offer choices and options to meet individual student needs.
6. Concepts are developed through direct experiences with science materials.
7. Instructional materials and strategies which are incorporated into the program permit movement toward a high degree of individualization.

ROLE OF THE STUDENT

The student will perform all kinds of activities (ranging from independent study to large group situations) which are uniquely appropriate to his learning style. This will permit him to progress continuously in content and process at a pace related to his abilities and interests.

ROLE OF THE TEACHER

The teacher will be a diagnostician of individual needs, a prescriber of appropriate materials and activities, and a facilitator of student achievement of educational objectives.

PURPOSE OF THE BIBLIOGRAPHY

The selected bibliography includes the following:

1. Suggested professional readings related to the philosophy and goals of the program;
2. Elementary textbooks which can supplement and enrich the program;
3. Secondary textbooks which can supplement or are a part of the program.

MAJOR UNIFYING CONCEPTS

I. Matter is composed of units called fundamental particles. These units of matter are thought to have certain structures and properties. Units of matter can be classified into hierarchies of organizational levels.

II. Living and non-living things in our biosphere interrelate in such a way that they tend to establish a balance in nature.

III. The behavior of one unit of matter may be altered by the presence of other units of matter. These interactions may be orderly or random.

IV. Units of matter, in the presence of energy, may be rearranged in such a way that the properties of a system undergo some change to give a new set of properties with the sum of energy and matter remaining constant as the system tends toward an equilibrium state.

V. Natural phenomena can be measured, described quantitatively, and/or predicted statistically.

PROCESSES OF INQUIRY

Observing

Classifying

Space/time relationships

Using numbers

Communicating

Measuring

Predicting

Inferring

Formulating hypotheses

Controlling variables

Experimenting

Defining operationally

Formulating models

Interpreting data

SCHEME FOR SCIENTIFIC LITERACY

The scientifically literate person:

1. should acquire knowledge which can be used to explain, predict, understand, and control natural phenomena.

2. should recognize that the meaning of science depends as much on its inquiry process as on its conceptual scheme and his ability to engage in the processes of science and to apply these processes in appropriate everyday situations.

3. should acquire the attitudes of scientists and learn to apply these attitudes appropriately in daily experiences.

4. understands that science is one but not the only way of viewing natural phenomena, and that even among the sciences there are different points of view.

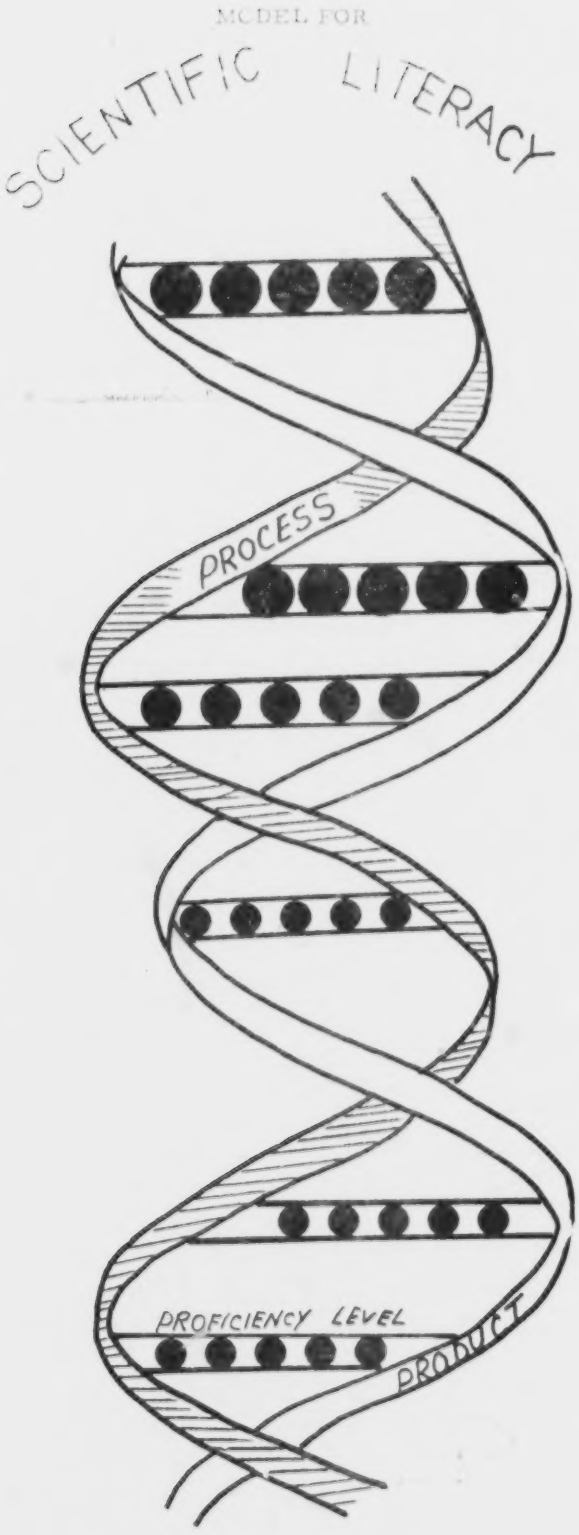
5. should come to understand the various interrelationships among science, technology, and society and to perceive his personal involvement in these activities.

6. appreciates the interaction of science and technology, recognizing that each reflects as well as stimulates the course of special development, but that science and technology do not progress at equal rates.

7. recognizes that knowledge in science evolves and that the knowledge of one generation may subsume, overturn, or complement previous knowledge.

8. should learn and develop numerous useful psychomotor skills through the study of science.

9. acquires a variety of interests in and enthusiasm for science that may lead to vocational and/or avocational interests.



The model for the student's scientific literacy illustrates the intermingling of the scientific process of investigation with the product of basic scientific principles. This intermingling is brought about in the learning experiences at each proficiency level. The model is open-ended to symbolize the need for continual education throughout an individual's life.

Taxonomy of Objectives

Proficiency Level No. 1

Proficiency Level Statement: Man has identified specific relationships that exist between living and non-living things in our biosphere.

Major Unifying Concept No. I, V

Proficiency Level Objective Statement: No. 1

The student will determine four properties of living and non-living things through observation and contact on the basis of the following list:

a. color	c. shape	e. hardness	g. taste
b. size	d. texture	f. weight	h. odor
			i. occupies space

Educational Objective Statements:

1. The student will group assorted objects according to color, size, shape, texture and hardness by observing, touching and grasping.

2. The student, after engaging in the activity such as filling a container with pebbles, will conclude that solids occupy space.

3. The student will, by using a measuring device, compare the relative weight of solid objects, using solids of the same size but different weight, and solids of different sizes and different weights.

4. The student will classify solid foods as either bitter, sweet, sour or salty.

5. The student will distinguish between objects that have pleasant and unpleasant odors, and those that are odorless.

6. The student will list the characteristics of some animals in terms of the following categories:

a. body coverings	d. occupies space
b. weight	e. color
c. shape	f. size

7. The student will identify the characteristics of plants in terms of the following categories:

a. weight	d. texture of stems and leaves
b. shape	e. color
c. occupies space	f. size

Taxonomy of Objectives

Proficiency Level No. 1

Proficiency Level Statement: Man has identified specific relationships that exist between living and non-living things in our biosphere.

Major Unifying Concept No. I, II, IV

Proficiency Level Objective Statement: No. 2

The student will differentiate between plants and animals.

Educational Objective Statements:

1. The student, after comparing plants and animals, will generalize that animals are able to move from one place to another, and that plant parts move, although the base of a plant remains in the same place.

2. The student will conclude that although plants vary in many ways, they have certain characteristics in common that place them in the animal kingdom.

3. The student will conclude that although animals vary in many ways, they have certain characteristics in common that place them in the animal kingdom.

4. The student will explain that animals have the same basic needs (such as food, water, air) that are necessary for life.

5. The student will compile a list of four common requirements for plant growth such as water, light, air and soil.

Taxonomy of Objectives

Proficiency Level No. 1

Proficiency Level Statement: Man has identified specific relationships that exist between living and non-living things in our biosphere.

Major Unifying Concept No. I, II

Proficiency Level Objective Statement: No. 3

The student will state the characteristics, uses, and locations of rocks and soil on the earth.

Educational Objective Statements:

1. The student will specify that the earth's crust is made up of solid materials (rocks and soil) and that they are randomly distributed.
2. The student will explain that formations such as mountains, valleys, hills and volcanoes are made of rocks and soil.
3. The student will group rocks according to shape, size, color, hardness, and texture.
4. The student will distinguish between rocks which are mixtures, layered, and/or have crystals.
5. The student will classify types of soil on the basis of characteristics in terms of:size of particles, color, and texture.
6. The student will explain how man uses rocks and soil.
7. The student will locate animals which live (a) beneath rocks and (b) in soil.

Taxonomy of Objectives

Proficiency Level No. 1

Proficiency Level Statement: Man has identified specific relationships that exist between living and non-living things in our biosphere.

Major Unifying Concept No. II

Proficiency Level Objective Statement: No. 4

The student will describe some plants and animals of a land habitat and a water habitat.

Educational Objective Statements:

1. The student will identify several plants and domesticated and wild animals, and their associated habitats, such as pastures, farm buildings, wooded areas, grass areas, farm pond and fields (crops).

2. The student will draw a picture of some typical plants and animals within the Chesapeake Bay environment.

3. The student will discuss some physical features, types of plants and kinds of animals present in a fresh water environment in Maryland.

Taxonomy of Objectives

Proficiency Level No. 1

Proficiency Level Statement: Man has identified specific relationships that exist between living and non-living things in our biosphere.

Major Unifying Concept No. I, II, III

Proficiency Level Objective Statement: No. 5

The student will discuss (a) at least three places where water can be found on the earth, air, soil, bodies of water, and (b) the effects of precipitation on man.

Educational Objective Statements:

1. The student will classify two types of bodies of water on earth, in terms of fresh and salt water.

2. The student will conclude that water can be found within soil.

3. The student will discuss (a) water in the air, (b) proper dress for different kinds of precipitation, and (c) safety precautions in storms.

Taxonomy of Objectives

Proficiency Level No. 1

Proficiency Level Statement: Man has identified specific relationships that exist between living and non-living things in our biosphere.

Major Unifying Concept No. I, V

Proficiency Level Objective Statement: No. 6

The student will describe four properties of a liquid from the following list:

a. taste
b. smell
c. physical appearance
d. weight
e. occupies space
f. takes shape of container

Educational Objective Statements:

1. The student will compare properties of various liquids in terms of taste, smell, and physical appearance.

2. The student will demonstrate that the liquid (a) takes up space, and (b) takes the shape of the container.

3. The student will demonstrate that liquids have weight.

Taxonomy of Objectives

Proficiency Level No. 1

Proficiency Level Statement: Man has identified specific relationships that exist between living and non-living things in our biosphere.

Major Unifying Concept No. I, V

Proficiency Level Objective Statement: No. 7

The student will characterize air as occupying space, having weight, being invisible, and capable of movement.

Educational Objective Statements:

1. The student will generalize that we are surrounded by an invisible form of matter called air.
2. The student will infer that air cannot be seen, but takes up space.
3. The student will demonstrate that air has weight.
4. The student will discover that wind is air that is moving.

Taxonomy of Objectives

Proficiency Level No. 1

Proficiency Level Statement: Man has identified specific relationships that exist between living and non-living things in our biosphere.

Major Unifying Concept No. I, III, V

Proficiency Level Objective Statement: No. 8

The student will discover what a force is and how forces can affect the motion of matter.

Educational Objective Statements:

1. The student will explain that (a) a force is a push or pull, (b) a force is needed to start or stop the motion of an object or change the direction of a moving object, (c) moving air acts as a force.
2. The student will specify that a greater motion can be produced by increasing the force.
3. The student will demonstrate how the following simple machines, lever, incline plane, and pulley, require less force to accomplish work.
4. The student will specify gravity as the force causing objects to fall.
5. The student will demonstrate that some objects float and some objects sink in water.
6. The student will observe that some objects float in air while some other objects do not float.

Taxonomy of Objectives

Proficiency Level No. 1

Proficiency Level Statement: Man has identified specific relationships that exist between living and non-living things in our biosphere.

Major Unifying Concept No. I, II, III

Proficiency Level Objective Statement: No. 9

The student will generalize the relationship between wind and two of the following: plants, animals and the earth's surface.

Educational Objective Statements:

1. The student will hypothesize that there is an interaction between a moving bird's wings (lift, thrust) and the invisible air needed to maintain a bird's flight.
2. The student will identify other animals that fly.
3. The student will observe that wind aids in dispersing seeds.
4. The student will generalize that wind can change the earth's features.

Taxonomy of Objectives

Proficiency Level No. 1

Proficiency Level Statement: Man has identified specific relationships that exist between living and non-living things in our biosphere.

Major Unifying Concept No. II, III

Proficiency Level Objective Statement: No. 10

The student will generalize that air is found in many places around us, but not in outer space.

Educational Objective Statements:

1. The student will explain that air can be found in soil.
2. The student will demonstrate the human body contains some air.
3. The student will discuss why astronauts carry an air supply into outer space.

Taxonomy of Objectives

Proficiency Level No. 1

Proficiency Level Statement: Man has identified specific relationships that exist between living and non-living things in our biosphere.

Major Unifying Concept No. IV, V

Proficiency Level Objective Statement: No. 11

The student will conclude that a change in temperature (heating and cooling) may result in a change in the state of matter.

Educational Objective Statements:

1. The student will describe the three states of matter.
2. The student will hypothesize that heating causes some solid matter to change to a liquid.
3. The student will recognize that some liquids change to solids when cooled.
4. The student will hypothesize that,after reaching a certain temperature, liquid matter changes to a gas (e.g., water vapor in popcorn).
5. The student will explain the observed change in terms similar to the statement that cooling causes a vapor to change to a liquid.

Taxonomy of Objectives

Proficiency Level No. 2

Proficiency Level Statement: The earth and moon receive heat and light from the sun.

Major Unifying Concept No. IV, V

Proficiency Level Objective Statement: No. 1

The student will conclude that the sun is our principal source of heat and light.

Educational Objective Statements:

1. The student will explain that the sun is not only a source of heat energy but also of light energy.
2. The student will generalize that when most matter is heated it expands; and when most matter is cooled, it contracts.
3. The student will relate the movement of liquid within a thermometer to expansion and contraction.
4. The student will summarize that (a) air temperature varies in different places at different times, and (b) air temperature is related to the sun's heat energy.
5. The student will describe the relationship between the sun's light, the moon, and the earth.

Taxonomy of Objectives

Proficiency Level No. 2

Proficiency Level Statement: The earth and moon receive heat and light from the sun.

Major Unifying Concept No. IV, V

Proficiency Level Objective Statement: No. 2

The student will explain the relationship of the earth, sun, moon system in terms of: size, comparative distances and motions.

Educational Objective Statements:

1. The student, using models of the earth and sun, will recognize that a small scale model can represent a much larger object.
2. The student will explain that the sun is much larger than the earth, although it appears smaller, because it is so far away.
3. The student will demonstrate that the moon is many times smaller than the earth.
4. The student will explain that the moon orbits the earth and is very far away.

Taxonomy of Objectives

Proficiency Level No. 2

Proficiency Level Statement: The earth and moon receive heat and light from the sun.

Major Unifying Concept No. III, IV

Proficiency Level Objective Statement: No. 3

The student will explain how shadows are formed, and how temperature is affected in the shadow area.

Educational Objective Statements:

1. The student will demonstrate that,when certain objects block light, a shadow is made.

2. The student will observe how clouds,passing in front of the sun's light form shadows on the ground,and conclude that the sun's light and heat can be partially blocked by clouds. (Caution: Children should never look directly at the sun).

Taxonomy of Objectives

Proficiency Level No. 2

Proficiency Level Statement: The earth and moon receive heat and light from the sun.

Major Unifying Concept No. II, IV, V

Proficiency Level Objective Statement: No. 4

The student will demonstrate movement of the earth as it relates to day and night, and to animal and plant adaptations.

Educational Objective Statements:

1. The student will summarize how the length and position of a shadow changes as the sun's position in the sky changes.
2. The student will associate the rotation of the earth as the cause of night and day and sunrise and sunset.
3. The student will discuss ways in which some animals, such as owls, rats, bats, or muskrats, are adapted to nocturnal activities, and others, such as crows, roosters, turtles, or cows are better adapted to diurnal activities.
4. The student will draw pictures of plant reactions to light and dark in terms of opening and closing of leaves and flowers.

Taxonomy of Objectives

Proficiency Level No. 2

Proficiency Level Statement: The earth and moon receive heat and light from the sun.

Major Unifying Concept No. II, IV, V

Proficiency Level Objective Statement: No. 5

The student will describe the differences in seasons in terms of weather conditions and its effects on living things.

Educational Objective Statements:

1. The student will indicate weather conditions such as:warm, cold, sunny, cloudy, windy, rainy, snowy and dry,using symbols to represent various weather conditions.

2. The student will compare the four seasons in terms of the weather changes in Maryland.

3. The student will discuss some protective devices and behavior of animals during the four seasons in terms of:body coverings, homes, migration, and hibernation.

4. The student will describe the cyclic change of deciduous plants during the four seasons in terms of:growth, leaves, and seed production.

Taxonomy of Objectives

Proficiency Level No. 3

Proficiency Level Statement: Environmental factors influence the growth of plants.

Major Unifying Concept No. I, II, IV, V

Proficiency Level Objective Statement: No. 1

The student will describe (a) differences and similarities of seeds and (b) needs for growth of a seed and (c) seedling in terms of vertical and lateral development.

Educational Objective Statements:

1. The student will group an assortment of seeds according to size, color, shape, texture and outer coverings.
2. The student will identify the protective covering, the tiny plant, and stored food of a seed.
3. The student will compare the number of seeds found in different fruits.
4. The student will discuss three things necessary for seed growth in terms of air, water, and temperature.
5. The student will tabulate the number of seeds that germinate in each of two groups, one in light and one in darkness, and will conclude that light is not needed for most types of seeds to germinate.
6. The student will draw comparative pictures of a seeds' vertical and lateral development each day until the seed sprouts above the surface of the soil.
7. The student will construct and analyze a graph to determine the period of greatest growth of a seedling over a period of fourteen days.

Taxonomy of Objectives

Proficiency Level No. 3

Proficiency Level Statement: Environmental factors influence the growth of plants.

Major Unifying Concept No. I, II, IV, V

Proficiency Level Objective Statement: No. 2

The student will summarize the function of the six main parts of green plants.

Educational Objective Statements:

1. The student will identify the parts of a plant in terms of roots, stems, leaves, flowers, fruits and seeds.
2. The student will observe that roots (a) are of varying sizes, and (b) hold a plant in place.
3. The student will conclude that regardless of a change in the orientation of a container holding a plant, the root will change its direction and again grow down.
4. The student will discuss (a) the change that occurs after supplying water to a plant that has been deprived of it for several days, (b) that water travels from roots to stem to leaves, and (c) that water is necessary for plant survival.
5. The student will explain that, (a) stems are different shapes and sizes, and (b) they support the leaves.
6. The student will generalize that all green leaves make food.
7. The student will specify differences and similarities in terms of shape, size, texture, irregular and regular edges, veining and lobes in leaves.
8. The student will specify differences and similarities in terms of:color, size, odor, number and shape of petals of flowers.
9. The student will conclude that flowers make fruit and seeds.
10. The student will specify six fruits that man uses for food.
11. The student will practice safety rules in terms of:eating or touching unknown plants.
12. The student will illustrate adult plant differences in terms of:size, shape, color, and texture.

Taxonomy of Objectives

Proficiency Level No. 3

Proficiency Level Statement: Environmental factors influence the growth of plants.

Major Unifying Concept No. I, II, IV, V

Proficiency Level Objective Statement: No. 3

The student will generalize that plants have varying requirements in terms of soil, temperature, light, water and air.

Educational Objective Statements:

1. The student will identify various soil samples in terms of those that are predominately loam, sand or clay.
2. The student will compare loam, clay and sand in terms of: water holding capacity and effect on plant growth.
3. The student will compare the growth of cactus bean and tomato plants in sandy soil, clay soil and loam.
4. The student will analyze the effect of different amounts of water on the growth of plants such as a cactus and bean plant in loam.
5. The student will compare the growth of a coleus plant in a hot location, a cold location and one approximately 70^{o}.
6. The student will illustrate that green plants need light for growth.
7. The student will, by blocking air from the leaves of plants, assess the need of a plant for air.

Taxonomy of Objectives

Proficiency Level No. 3

Proficiency Level Statement: Environmental factors influence the growth of plants.

Major Unifying Concept No. II, IV

Proficiency Level Objective Statement: No. 4

The student will describe plant adaptations in terms of protective devices, food, and seed dispersal.

Educational Objective Statements:

1. The student will give at least three examples of protective devices, such as poisons, colors, odors, or outer coverings, which help plants adapt to their environment.
2. The student will compare green and non-green plants in terms of appearance and habitat.
3. The student will explain that some plants make their own food, whereas others live on dead materials or other living things.
4. The student will discuss ways in which seeds are dispersed and their chances of survival.

Taxonomy of Objectives

Proficiency Level No. 4

Proficiency Level Statement: Animals are adapted to their environment.

Major Unifying Concept No. II, IV, V

Proficiency Level Objective Statement: No. 1

The student will explain the relationship between plants and animals in the food chain.

Educational Objective Statements:

1. The student will explain that (a) some animals eat only plants, (b) some animals eat other animals, and (c) some animals eat both plants and animals.
2. The student will trace the source of foods from plant to animal in terms of a food chain.
3. The student will indicate on a day to day basis, the food that he has consumed in terms of (a) dairy products, (b) meat, poultry, fish, (c) grains, (d) vegetables and fruits.
4. The student will trace the source of energy for man coming from food back to either an animal or a plant.

Taxonomy of Objectives

Proficiency Level No. 4

Proficiency Level Statement: Animals are adapted to their environment.

Major Unifying Concept No. I, II, V

Proficiency Level Objective Statement: No. 2

The student will describe growth and change of two animals such as mammals and fish in terms of (a) being born alive or hatched from an egg, (b) physical appearance, (c) behavior, and (d) basic needs.

Educational Objective Statements:

1. The student will compare some animals which supply certain needs for their young, as compared to some which do not.
2. The student will conclude that some animals are born alive and some are hatched from eggs.
3. The student will compare the number of offspring produced at a given time by parents and their resemblance to parents.
4. The student will list three basic needs of animals, such as adequate food and water, temperature range, and shelter or protection.
5. The student will explain that offspring grow and change in terms of size, shape, structure, and behavior.

Taxonomy of Objectives

Proficiency Level No. 4

Proficiency Level Statement: Animals are adapted to their environment.

Major Unifying Concept No. I, II

Proficiency Level Objective Statement: No. 3

The student will compare vertebrates and invertebrates and how they are adapted to their environment.

Educational Objective Statements:

1. The student will conclude that some animals have backbones and some do not.
2. The student will group those animals which have backbones and those which do not.
3. The student will discuss how animals with backbones and animals without backbones are adapted to their environment.

Taxonomy of Objectives

Proficiency Level No. 4

Proficiency Level Statement: Animals are adapted to their environment.

Major Unifying Concept No. I, II

Proficiency Level Objective Statement: No. 4

The student will describe how the following invertebrates are adapted to their environment: mollusks, arthropods, and worms.

Educational Objective Statements:

1. The student will specify the distinguishing characteristics for each of the following groups: mollusks and arthropods (insects, spiders, and crabs).
2. The student will describe how worms are adapted to their environment.
3. The student will explain how mollusks are adapted to their environment.
4. The student will explain how arthropods (insects, spiders, and crabs) adapt to their environment in terms of body coverings, method of locomotion, body parts and senses (seeing, smelling, and hearing).
5. The student will discuss characteristics of animals in each stage of complete and incomplete metamorphosis.

Taxonomy of Objectives

Proficiency Level No. 4

Proficiency Level Statement: Animals are adapted to their environment.

Major Unifying Concept No. I, II, V

Proficiency Level Objective Statement: No. 5

The student will describe how the following vertebrates are adapted to their environment: birds, mammals, reptiles, amphibians, fish.

Educational Objective Statements:

1. The student will specify the distinguishing characteristics for each of the following groups: fish, amphibians, reptiles, birds and mammals.

2. The student will explain why amphibians can live in water and on land in terms of:body coverings, body temperature and physical features.

3. The student will specify three characteristics of fish that permit them to live in water, in terms of:body temperature, body covering, locomotion, breathing apparatus and senses.

4. The student will describe reptiles in terms of:body temperature, body covering, senses, lungs and physical features for mobility (which allows for adaptation on land and water or both).

5. The student will identify three characteristics of birds, such as feathers, wings, body temperature, senses and skeletal structure which help them to adapt to their environment.

6. The student will describe how the characteristics of mammals help them adapt to their environment in terms of: body temperature, breathing apparatus, method of locomotion, body covering and senses (seeing, smelling, hearing).

Taxonomy of Objectives

Proficiency Level No. 4

Proficiency Level Statement: Animals are adapted to their environment.

Major Unifying Concept No. II, III, V

Proficiency Level Objective Statement: No. 6

The student will conclude that there are many kinds of sounds produced by vibrating objects and that certain sounds enable living things to communicate.

Educational Objective Statements:

1. The student will identify some living and non-living objects by the sounds they make.
2. The student will conclude that sounds are produced by vibrating objects.
3. The student will discuss (a) how loud and soft sounds can be produced and (b) how low and high sounds are made.
4. The student will specify some pleasant and unpleasant sounds made by living and non-living things.
5. The student will explain (a) how animals have certain ways of communicating with each other and (b) how communication helps them adapt to their environment.

Taxonomy of Objectives

Proficiency Level No. 4

Proficiency Level Statement: Animals are adapted to their environment.

Major Unifying Concept No. II, III, IV

Proficiency Level Objective Statement: No. 7

The student will specify five specialized ways in which animals protect themselves from enemies in terms of the list below:

1. toxic matter
2. specialized body coverings, such as color, shells, spines or scales
3. other body parts, such as hoofs, claws and teeth
4. inborn and learned behavior.

Educational Objective Statements:

1. The student will illustrate how five animals can use their body coverings for protection.

   a. color which camouflages (such as some female birds)
   b. color which changes (such as a chameleon)
   c. shells (such as a snail)
   d. spines (such as a porcupine)
   e. scales (such as an alligator).

2. The student will list three animals, such as rattlesnakes, some species of bees, scorpions, black widow spiders and skunks, that employ the use of toxic material for protection against other living things.

3. The student will compile a list of six animals and their special protective parts or devices such as claws of a cat, hoofs of a horse, teeth of a dog.

4. The student will discuss how inborn and learned behaviors help animals protect themselves in their environment.

Taxonomy of Objectives

Proficiency Level No. 4

Proficiency Level Statement: Animals are adapted to their environment.

Major Unifying Concept No. II, III, IV, V

Proficiency Level Objective Statement: No. 8

The student will differentiate between living and non-living things.

Educational Objective Statements:

1. The student will demonstrate that animals can learn to respond to a stimulus and that non-living things move as a result of external forces.
2. The student will explain that living things have certain needs which are not shared by non-living things.
3. The student will conclude that growth occurs only when a thing is living.
4. The student will explain that non-living matter can affect living things such as the force of rapidly flowing water on plants or insufficient water or air supply for plants and animals.

Taxonomy of Objectives

Proficiency Level No. 5

Proficiency Level Statement: Changes on earth occur through time.

Major Unifying Concept No. III, IV

Proficiency Level Objective Statement: No. 1

The student will generalize that the earth's surface can be changed by flowing water.

Educational Objective Statements:

1. The student will demonstrate how precipitation erodes the earth's surface.
2. The student will explain that a force called gravity causes water to flow from a higher level to a lower level.
3. The student will demonstrate how streams, rivers, and canyons are formed.
4. The student will demonstrate how streams can carry and redeposit soil to form deltas and fill up lake bottoms.
5. The student will show how water finds a natural path and collects in a basin, forming a lake.
6. The student will summarize how water movement brings about erosion of the shore line.
7. The student will assess ways of preventing erosion caused by water.
8. The student will construct a model depicting water sheds, check dams, and a reservoir in order to illustrate how these help man conserve and use water.

Taxonomy of Objectives

Proficiency Level No. 5

Proficiency Level Statement: Changes on the earth occur through time.

Major Unifying Concept No. II, III, IV

Proficiency Level Objective Statement: No. 2

The student will discuss the water cycle in terms of evaporation, condensation and transpiration.

Educational Objective Statements:

1. The student will explain that some liquid can change to water vapor in the air (evaporation).
2. The student will infer that water vapor from the air can condense.
3. The student will construct a diagram that traces the water flow from soil, to root, to stem, to leaves and into the atmosphere (transpiration) in a plant.
4. The student will describe the water cycle from plant, to atmosphere, and back to the plant.
5. The student will construct a chart of the water cycle for a large body of water.

Taxonomy of Objectives

Proficiency Level No. 5

Proficiency Level Statement: Changes on earth occur through time.

Major Unifying Concept No. I, II, III, IV, V

Proficiency Level Objective Statement: No. 3

The student will describe pollutants in terms of (a) altering the normal composition of air and water, (b) affecting living things and (c) means of control.

Educational Objective Statements:

1. The student will discuss the relative proportions of gases in air such as N_2, O_2, and CO_2, as well as varying amounts of water vapor in the air.
2. The student will infer that by decreasing the supply of air with such things as water, dirt or a chemical extinguisher, oxidation (burning) can be stopped.
3. The student will list the types of air pollution found in his community in terms of source, type,and quantity.
4. The student will compile a list of several examples of ways in which plants and animals are affected by air pollution.
5. The student will describe ways in which water becomes polluted.
6. The student will summarize the effects of polluted water on living things.
7. The student will prescribe ways of eliminating pollutants from air and water.

Taxonomy of Objectives

Proficiency Level No. 5

Proficiency Level Statement: Changes on the earth occur through time.

Major Unifying Concept No. II, III, IV

Proficiency Level Objective Statement: No. 4

The student will discuss some different kinds of weather changes such as wind temperature, and precipitation and their effects on the earth's surface.

Educational Objective Statements:

1. The student will relate changes in temperature to the various states of water.
2. The student will specify how different kinds of precipitation such as sleet, rain, snow, and hail are formed.
3. The student will discuss tornadoes and thunderstorms in terms of weather changes which are associated with them.
4. The student will describe the damage that can be caused by strong winds, heavy precipitation, and extreme temperatures.
5. The student will analyze how mechanical weathering (expansion and contraction of rocks due to temperature changes and ice in cracks of rocks) causes changes on the earth's surface.

Taxonomy of Objectives

Proficiency Level No. 5

Proficiency Level Statement: Changes on the earth occur through time.

Major Unifying Concept No. I, II, III, IV, V

Proficiency Level Objective Statement: No. 5

The student will explain how soil and different kinds of rocks are formed over long periods of time.

Educational Objective Statements:

1. The student will conclude that soil is made of rock particles.
2. The student will locate examples of how living things affect the soil in terms of decay, root breakup of rocks, amount of humus (dead plants and animals) in the soil and how the soil is aerated by worms, beetles, etc.
3. The student will explain the relationship of weathering and erosion to the formation of sedimentary rocks.
4. The student will describe that igneous rocks are formed by heat.
5. The student will summarize that metamorphic rocks are formed by heat and pressure over long periods of time.

Taxonomy of Objectives

Proficiency Level No. 5

Proficiency Level Statement: Changes on earth occur through time.

Major Unifying Concept No. I, II, III, IV, V

Proficiency Level Objective Statement: No. 6

The student will summarize (a) the development of living things from prehistoric to modern times in terms of adaptation from water to land to air and (b) why some living things have become extinct.

Educational Objective Statements:

1. The student will compare the physical appearance of prehistoric living things to living things of today.
2. The student will trace the development of animals in terms of:
   a. origin of life in the sea
   b. adaptations of animals for water, land, and air environments.
3. The student will discuss the development of various plants over the ages.
4. The student will hypothesize as to why some living things such as dinosaurs became extinct.

Taxonomy of Objectives

Proficiency Level No. 5

Proficiency Level Statement: Changes on earth occur through time.

Major Unifying Concept No. II, III, IV

Proficiency Level Objective Statement: No. 7

The student will discuss how coal, oil, and peat are formed and how man makes use of them.

Educational Objective Statements:

1. The student will design a chart depicting what fossil fuels are made of and under what conditions they were formed.
2. The student will specify how fuels, such as coal, peat, and oil are used by man.
3. The student will summarize the changes which have occurred in each sample of burning peat, oil and coal in terms of color of flame, amount of smoke, intensity of heat and light, the resultant residue and their effects on the environment.

Taxonomy of Objectives

Proficiency Level No. 6

Proficiency Level Statement: Amounts, types, and uses of energy vary.

Major Unifying Concept No. IV, V

Proficiency Level Objective Statement: No. 1

The student will discuss light in terms of: (a) the relationship between heat and light energy, (b) how light travels, (c) visible spectrum, (d) how light travels through different materials and (e) how light varies with change in distance.

Educational Objective Statements:

1. The student will explain that (a) many objects which emit heat also give off light, and (b) heat and light are related forms of energy.
2. The student will explain how messages are carried from the eye to the brain.
3. The student will explain that light (a) travels in a straight line from its source, (b) does not travel around a corner, and (c) spreads in all directions.
4. The student will generalize that sunlight, in order to be separated into visible colors, must go through something such as a prism or water.
5. The student will conclude that light becomes less bright as the distance from the source increases.
6. The student will classify various objects in terms of opaque, translucent, or transparent.

Taxonomy of Objectives

Proficiency Level No. 6

Proficiency Level Statement: Amounts, types, and uses of energy vary.

Major Unifying Concept No. I, III, IV, V

Proficiency Level Objective Statement: No. 2

The student will explain that surfaces reflect light in varying intensities.

Educational Objective Statements:

1. The student will demonstrate that rays of sunlight are reflected from mirrors to other objects.
2. The student will specify that non-luminous objects are visible because of reflected lights.
3. The student will rank some materials in terms of those that best reflect light to those that are poor reflectors of light.
4. The student will compare reflectivity in terms of the following surface properties: light and dark colors, shiny and dull, and smooth and rough surfaces.
5. The student will conclude that objects which reflect light usually have a lower temperature than objects that do not reflect light.

Taxonomy of Objectives

Proficiency Level No. 6

Proficiency Level Statement: Amounts, types and uses of energy vary.

Major Unifying Concept No. II, III, IV, V

Proficiency Level Objective Statement: No. 3

The student will explain (a) causes of night, day, and seasons, (b) their relationship to the amount of heat and light energy received by the earth, (c) how seasons affect deciduous plants, (d) relate plant light responses to the day-night cycle.

Educational Objective Statements:

1. The student will explain sunlight falling on the earth as it rotates on its axis causing day and night.
2. The student will relate light responses of animals and plants to the day-night cycle.
3. The student will compare slanting and direct rays in terms of: (a) causes, (b) intensity, and (c) amount of heat generated.
4. The student will specify (a) the seasons the North Temperate Zone and the South Temperate Zone would be having as the earth revolves about the sun, (b) factors involved in the cause of seasons in terms of tilt of the axis and direct and slanting rays of the sun as they relate to light and heat energy, and (c) time it takes for the earth to make one revolution around the sun.
5. The student will conclude that the night time sky appears to change with the seasons.
6. The student will discuss how varying amounts of heat and light affect deciduous plants in terms of growth, color, effect on leaves, and flower and seed production.
7. The student will compare the amount of heat and light energy received in arctic, temperate and equatonal regions.

Taxonomy of Objectives

Proficiency Level No. 6

Proficiency Level Statement: Amounts, types, and uses of energy vary.

Major Unifying Concept No. II, III, IV, V

Proficiency Level Objective Statement: No. 4

The student will construct a chart showing three adaptations for both a plant and an animal which help the organism survive in (a) temperate region, (b) tropical region and (c) arctic region.

Educational Objective Statements:

1. The student will compare tropical, arctic, and temperate regions in terms of: climate, typical soil conditions, annual precipitation and water supply, and dominant plant and animal populations.

2. The student will explain how the animals of the arctic, temperate, and tropical region are adapted to (a) compete for resources, and (b) protect themselves within their environment from enemies, overcrowding, and unusual temperature changes.

Structure	Behavior
type of body covering	eating habits (types of food)
size	speed of locomotion
type of feet	protective behaviors
mouth parts, teeth	nocturnal or diurnal
sensory organs	activity oriented
protective devices	type of shelter used
(including body temp.)	methods of obtaining water

3. The student will discuss ways in which the plant is adapted to (a) compete for resources (water, minerals, air, light and heat energy), and (b) survive overcrowding, enemies, drought, unusual temperatures, or soil depletion in a temperate, arctic, and humid tropical region.

Plant Characteristics
coverings
color
size
shape
type of roots, stems, leaves, fruits, flowers, seeds
toxic materials
special adaptations

Taxonomy of Objectives

Proficiency Level No. 6

Proficiency Level Statement: Amounts, types, and uses of energy vary.

Major Unifying Concept No. II, III, IV, V

Proficiency Level Objective Statement: No. 5

The student will discuss photosynthesis in terms of: (a) angiosperms and gymnosperms which carry on photosynthesis, (b) the heat and light energy needed, (c) acquiring and using necessary materials for food production, (d) the ways in which the plant uses the food it produces, and (e) the ways in which man makes use of food stored in plants.

Educational Objective Statements:

1. The student will describe the characteristics of angiosperms and gymnosperms which perform photosynthesis in terms of the following: seed locations, external structure of leaf, and seasonal effects on leaves.

2. The student will explain how green plant leaves make food in terms of: (a) materials and energy needed from the environment (water, carbon dioxide, sun's light and heat), (b) the parts of the plant (roots, stems, leaves) used for getting these supplies, (c) the role of chlorophyll in food making, and (d) the plant's use of food (growth, new parts, stored).

3. The student will explain that photosynthesis is affected by the lack of light, and the amount of light affects growth.

4. The student will summarize that man eats many different parts of plants, such as roots, stems, leaves, flowers, fruits and seeds.

   List of some foods from various parts of plants.

Seeds	Fruits	Roots	Stems	Leaves	Flowers
wheat	apples	carrots	celery	lettuce	broccoli
rice	cucumbers	beets	white potatoes	cabbage	cauliflower
beans	tomatoes	radishes	asparagus	spinach	
peas	melons				
corn	berries				

5. The student will group different plants that he eats as annual or perennial.

6. The student will summarize how plants can be grown by vegetative reproduction.

7. The student will specify (a) where toxic substances in some plants (b) the effect on animals and (c) safety rules pertaining to unknown plants.

Taxonomy of Objectives

Proficiency Level No. 6

Proficiency Level Statement: Amounts, types, and uses of energy vary.

Major Unifying Concept No. I, II, IV

Proficiency Level Objective Statement: No. 6

The student will discuss the sources in which non-green plants obtain energy from dead or decaying matter and living matter.

Educational Objective Statements:

1. The student will compare structure of green plants with non-green plants.
2. The student will explain why non-green plants cannot make their own food.
3. The student will generalize that non-green plants which cannot make their own food derive energy from (a) dead or decaying matter, especially in damp conditions and (b) from living things.

Taxonomy of Objectives

Proficiency Level No. 6

Proficiency Level Statement: Amounts, types and uses of energy vary.

Major Unifying Concept No. II, III, IV

Proficiency Level Objective Statement: No. 7

The student will summarize chemical energy in terms of;(a) chemical reactions and (b) conversion (chemical energy converted to heat and light energy).

Educational Objective Statements:

1. The student will describe a chemical reaction.
2. The student will conclude that chemical energy can be converted into heat and light energy.
3. The student will infer that the chemical energy from a dry cell can be changed into electrical energy and can activate an object such as a flash light or a buzzer.

Taxonomy of Objectives

Proficiency Level No. 6

Proficiency Level Statement: Amounts, types, and uses of energy vary.

Major Unifying Concept No. IV, V

Proficiency Level Objective Statement: No. 8

The student will discuss electrical circuits in terms of the mechanics of making simple circuits and applications.

Educational Objective Statements:

1. The student will display safety consciousness in the use of electrical equipment.
2. The student will demonstrate how to make a simple circiut using a socket, light bulb, dry cell, and wire (first using one wire and then using two).
3. The student will discover the effect of open and closed circuits on the flow of electricity, and face the flow of electricity from one terminal to bulb to the other terminal.
4. The student will explain how a switch can be used for opening or closing circuits.
5. The student will explain (a) the flow of electricity through a filament of a clear electric bulb and (b) the two forms of energy produced by a light bulb.
6. The student will explain that the gas glows in a flourescent bulb when electricity flows through it.
7. The student will rank the brightness of light in an electrical circuit in relation to number of dry cells used (total number of dry cells not to exceed 18 volts).
8. The student will record eight ways in which electricity is used in his home.

Taxonomy of Objectives

Proficiency Level No. 6

Proficiency Level Statement: Amounts, types, and uses of energy vary.

Major Unifying Concept No. I, III, IV, V

Proficiency Level Objective Statement: No. 9

The student will summarize five characteristics of magnets and how man uses them.

Educational Objective Statements:

1. The student will generalize that magnets attract objects of iron or steel by exerting a force.
2. The student will discover that lodestones are natural magnets.
3. The student will generalize that magnets can attract through things that are non-magnetic.
4. The student will conclude that the two ends (poles) of different kinds of magnets have the strongest attraction.
5. The student will discover that unlike poles attract and like poles repel.
6. The student will predict the direction of movement of a bar magnet which can swing freely.
7. The student will infer that a compass has a free swinging bar magnet which is affected by the earth's magnetic poles, after examining a map showing the earth's magnetic and geographic poles and identifying north and south in relation to the schoolroom.
8. The student will generalize that magnets can be made out of only those objects which would be attracted to magnets.
9. The student will specify three ways in which man uses magnets, such as picking up nails or pins, in toys, or using magnets to attach something to an iron or steel surface.

Taxonomy of Objectives

Proficiency Level No. 6

Proficiency Level Statement: Amounts, types, and uses of energy vary.

Major Unifying Concept No. I, II, III, IV, V

Proficiency Level Objective Statement: No. 10

The student will formulate generalizations concerning electromagnets in terms of: (a) construction of electromagnets, (b) relative strength of attractions of different electromagnets and (c) applications.

Educational Objective Statements:

1. The student will demonstrate that an electromagnet is formed when a wire is attached to both terminals of a dry cell battery, thereby producing a flow of electricity through the wire, when a wire is coiled, and when a wire is wrapped around a core.

2. The student will conclude that only iron or steel objects function as cores for electromagnets.

3. The student will design experiments showing how the strength of electromagnets can be increased by (a) increasing the number of coils around the core, (b) type of core, and (c) using more than one dry cell.

4. The student will determine the North and South poles of an electromagnet, using a compass.

5. The student will specify four ways electromagnets are used, such as: electric motors, lifting heavy loads of iron and steel, removing iron from coal in furnaces, doorbells, and telegraph systems.

Taxonomy of Objectives

Proficiency Level No. 6

Proficiency Level Statement: Amounts, types, and uses of energy vary.

Major Unifying Concept No. III, IV

Proficiency Level Objective Statement: No. 11

The student will specify three types of energy (electrical, solar, and heat) which can be changed to mechanical energy.

Educational Objective Statements:

1. The student will specify how electrical energy can be changed to mechanical energy after constructing a simple electric motor.
2. The student will infer that heat energy can be changed to mechanical energy.
3. The student will conclude that solar energy can be changed to mechanical energy by using the radiometer.
4. The student will conclude that machines need an energy supply in order to work.

Taxonomy of Objectives

Proficiency Level No. 6

Proficiency Level Statement: Amounts, types, and uses of energy vary.

Major Unifying Concept No. II, IV, V

Proficiency Level Objective Statement: No. 12

The student will conclude that a force is needed to do work.

Educational Objective Statements:

1. The student will conclude that energy is needed to produce a force.
2. The student will generalize that (a) more force is needed to push heavier objects than light objects, (b) objects move in the direction of the force involved, (c) a force is needed to change direction, and (d) a force is needed to stop an object in motion.
3. The student will conclude that work is done when a force moves through a distance.
4. The student will explain that when forces are equal and opposing, no work is done since the object does not move; secondly, that when forces are opposing, but not equal, the object does move and work is done.

Taxonomy of Objectives

Proficiency Level No. 6

Proficiency Level Statement: Amounts, types, and uses of energy vary.

Major Unifying Concept No. I, II, III, IV, V

Proficiency Level Objective Statement: No. 13

The student will explain how levers and incline planes make work easier.

Educational Objective Statements:

1. The student will locate the fulcrum, load arm, and force arm for a first class lever.
2. The student will analyze that levers can push, pull and lift using some first class levers.
3. The student will explain that (a) a lever can change the direction of a force, (b) more force is needed as the length of the load arm increases and the length of the force arm decreases, and (c) the distance the force arm travels is inversely proportionate to the amount of force exerted.
4. The student will predict that when a weight is moved a certain distance (a) less force is needed when incline plane is used and that more force is needed when an incline plane is not used, (b) the amount of force used is related to the length of the plane and angle of incline.
5. The student will explain that machines can make work easier and can reduce the force needed to do work after comparing work done with and without a machine.

Taxonomy of Objectives

Proficiency Level No. 6

Proficiency Level Statement: Amounts, types, and uses of energy vary.

Major Unifying Concept No. III, IV, V

Proficiency Level Objective Statement: No. 14

The student will discuss friction in terms of (a) a force resulting from two objects rubbed together, (b) heat as a result of friction, (c) three ways friction can be decreased, (d) three ways friction can be increased.

Educational Objective Statements:

1. The student will conclude that friction (a) is a force which leads to stop motion, and (b) is a result of materials rubbing together.
2. The student will list examples where frictional energy is associated with heat.
3. The student will state that (a) light weight objects offer less resistance than heavy, (b) rough surfaces have more resistance than smooth because they catch and drag, and (c) rubbing an object more briskly increases friction.
4. The student will compare rolling and sliding friction using practical examples.
5. The student will demonstrate that lubrication reduces friction.
6. The student will conclude that friction causes wear.
7. The student will describe when friction is beneficial.

Taxonomy of Objectives

Proficiency Level No. 6

Proficiency Level Statement: Amounts, types, and uses of energy vary.

Major Unifying Concept No. III, IV, V

Proficiency Level Objective Statement: No. 15

The student will explain (a) kinetic and potential energy in terms of energy of moving objects and stored energy respectively, and (b) factors which affect amount of kinetic energy in terms of heights, weight, and speed.

Educational Objective Statements:

1. The student will explain how each of the following represent kinetic or potential energy:

   a. water behind a dam
   b. rock set on top of cliff
   c. lump of coal
   d. falling ball
   e. watch spring
   f. waterfall
   g. bowling ball going down alley
   h. wind

2. The student will demonstrate that potential energy can be changed to kinetic energy by using a pendulum or a spring.

3. The student will explain that the height from which something falls, and the weight and speed of an object, is directly related to the amount of kinetic energy.

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